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LAMONT GEOLOGICAL OBSERVATORY

PALISADES, NEW YORK

TIDAL VARIATION OF HYDROGRAPHY OF BLOCK ISLAND SOUND OBSERVED IN AUGUST 1965

Report prepared by: Takashi Ichiye

Technical Report No. CU-15-67 to the Office of Naval Research
Contract Nonr 266(48)

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ABSTRACT

The hydrographic survey of Block Island Sound was carried out on August 17th to the 19th, 1965 on board the R/V UCONN of the University of Connecticut and the R/V CONRAD, JR. of Lamont Geological Observatory. The two ships made several runs of two triangular circuits of hydrographic stations. The temperature and salinity data at each sections are arranged according to the tidal stage at the Race. The readings of the portable salinometers are compared with the bucket temperatures, BT data and the laboratory salinometer data. The fluctuations of temperature and salinity at different tidal stages are maximum at the deep layer of the central portion of the southern channel. The composite T-S diagrams of the whole stations indicate that the water temperature ranges from 10° C to 23° C and the salinity ranges from 30°/oo to 32°/oo. The water from Newport Bight has low temperature (less than 18° C) and low salinity (less than 30.5°/oo), while the water of the subarctic origin has the lowest temperature (less than 14° C) and the highest salinity (more than 31.5°/oo). The former flows into the sound through the eastern channel during the flood and leaves the sound through the southern channel during the ebb, while the latter enters through the central part of the southern channel during the flood, moves to the northwest and leaves the sound along the northern coast during the ebb. A simple mathematical model on mixing of different water masses in the sound is proposed on the basis of the Lagrangian method for treating mixing along a trajectory of each water mass.

1. Introduction

From August 17th to the 20th in 1965 an oceanographic survey was carried out in Block Island Sound on board the R/V UCONN of the University of Connecticut and the CONRAD, Jr. a work boat of Lamont Geological Observatory. The two boats made several circuits at different tidal stages along triangular paths between the mainland and Block Island--- Montauk Point (See Fig. 1). The UCONN and the CONRAD, Jr. occupied forty-nine stations and twenty-four stations respectively along the eastern and western triangular circuits. Scientific personnel participating on the cruise were T. Ichiye, R. Leyden, G. Mathews, and F. Zbar on board the UCONN and on board the CONRAD, Jr. were N. Plutchak and M. Salkind.

At each station, temperature salinity and conductivity were measured with portable salinometers (manufactured by Industrial Instruments Co.) at about ten feet intervals. Bathythermographs were also used. Wind and air temperatures were occasionally measured with a hand anemometer and a mercury thermometer.

A party from the U.S. Coast and Geodetic Survey on board the USC/GS Marmer under Commander Poor was also measuring tidal currents at the byoys set out in the sound during the period of the present survey.

The weather on the 17th was foggy in the morning but became partly cloudy with the cloud amount between 8 and 4 in the afternoon. The wind was calm in the morning with a southerly wind of 3 to 5 knots becoming strong in the evening. In the morning of the 18th, it was

hazy with stratus clouds covering the whole sky and the wind calm to the Beanfort Scale (BS) 2. In the afternoon the sky cleared up to a cloud cover of 6 to 7 with the south wind of BS 2 to 3. In the evening it became foggy with total cloud cover and the south or east southeast wind increased its force to BS 3. On the 19th it rained during the daytime except for a foggy break near noontime. The wind was south or southwest with a force of BS 3 to 4 in the morning and of BS 2 in the afternoon. During the daytime of the 20th, the weather was fair and the wind force was BS 2 to 3 from the north.

2. Calibration of portable salinometer.

The portable salinometers are convenient instruments for nearshore studies but they are not tested for their accuracy in field use. Therefore, it seems to be necessary to check the manufacturer's claim of their accuracy. Eighteen surface water samples were taken at the stations of the western circuit and their salinities were determined with a laboratory salinometer. These values are plotted against the readings by the portable salinometer in the field in Fig. 1 (A). The least square method yields the relationships with a 90% confidence limit between the lab salinity S_l and the field value S_p as:

$$S_l = 0.72\ S_p + 8.72 \pm 0.13 \qquad (\text{in}\ ^o/oo). \qquad (1)$$

Therefore the portable salinometer may have an accuracy within the limit of at least 0.15 (^{o}/oo) if it is used with the proper calibration;

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

the manufacturer's claim of an accuracy of $\pm$ 0.1 ($^o/oo$) is an over estimate.

The water temperatures (T_p) measured with the portable salinometer versus those with the bathythermographs (T_b) are plotted in Fig. 2 (B) and 2(C) respectively for the western and eastern circuit. The least square relationships between T_b and T_p with a 95% confidence limit are given by

$$T_b = 0.977\ T_p + 0.34 \pm 0.55 \qquad (\text{in } ^oC) \qquad (2)$$

$$T_b = 0.923\ T_p + 1.10 \pm 0.75 \qquad (\text{in } ^oC) \qquad (3)$$

respectively for Fig. 2 (B) and 2 (C). The temperatures used for Fig. 2 (B) and 2 (C) were at the surface, 10 feet and the 20 feet depth. The temperature readings by the protable salinometers seem to show more scatterings than the salinity readings. However, this may be partly due to the large members of the samples. On the other hand, there is a difference between the portable salinometers used in the western and the eastern circuits, as seen in Fig. 2 (B) and 2 (C). Particularly the salinometer used on the eastern circuit seemed to give higher values than the bathythermograph data if the instrument was lowered faster than the ordinary rate at which the thermal sensor reaches equilibrium state. This is because the sensor was exposed to air temperature higher than water temperature when it was not used in the water. The data with the extreme deviations in the portable salinometer readings in Fig. 2 (C) are excluded from the calculation of the

least square relation of equation (3).

3. Outline of the hydrography of Block Island Sound.

Block Island Sound has been for many years a test ground for the underwater sound propagation study by the U.S. Navy Underwater Sound Laboratory of New London, Connecticut. A review of the physical oceanography of the sound was prepared by Williams (1967).

Block Island Sound is a partly closed parallel-piped body of water with long and short sides of 35 and 15 nautical miles running WSW to ENE and S to N respectively. To the west it is connected with Long Island Sound by the Race, to the east with Newport Bight and to the south with the Atlantic Ocean. The bottom topography shows shallow parts less than 30 m along the northern coast and in the southwestern section, and the deepest areas of almost 100 m in the Race. The bottom topography also showed a trough deeper than 50 m in the central part of the channel between Block Island and Montauk Point.

The hydrographic surveys of the Sound were carried out in August, 1951 and January, 1952 by a group from Cornell University (Ayers et al, 1952). Their data about the salinity distributions indicated that the Sound is not influenced by land drainage except near the Rhode Island coast in contrast with Long Island Sound. However, the existence of large horizontal gradients of temperature and salinity below the mid-depths even in summer suggests that the change of these quantities due to tidal advection may be rather conspicuous.

4. Temperature-salinity relationships.

In order to see the average condition and variability of the temperature-salinity relationships, all the temperature-salinity data obtained in the eastern circuit are plotted as a T-S diagram in Fig.3. The three sections are represented by different symbols and the data below the 60 feet depth are also indicated by special symbols.

The temperature ranges from 10° to 23° C and the salinity ranges from 29.9 to 32.4 ‰. The water in the section (II) between Block Island and Montauk Point was generally colder and more saline than in the other sections because of the influx of the offshore water of low temperature and high salinity. The water with temperature lower than 14° C was found below the 60 feet depth except in Section II where the cold water was found at even shallower depths. The wide range of temperature in Block Island Sound, particularly in Section II, is quite different from the temperature distribution in Long Island Sound. There at Long Island Sound the temperature stratification is small even in summer time due to the strong stirring by the tidal currents.

5. Vertical profiles of temperature and salinity

In Fig. 4, the vertical profiles of temperature measured with the bathythermograph in the eastern circuit are plotted. In Fig. 5 corresponding profiles of salinity measured with the portable salinometer are plotted. Both temperature and salinity data are grouped

[illegible]

[illegible]

[illegible]

[illegible]

together according to the tidal stages at Race.

In Section I which inludes Stations I to 6 (Fig. 1), water with temperature less than 15°C was always found below 50 feet in the northern part. This water comes to the sound from Newport Bight. Temperature differences between the high water and low water are largest near the bottom of the central portion, the high water corresponding to higher temperature(Fig. 6). The temperature at high water is higher than at low water in the western section. In Section II, the extrememly cold water with temperature 10°C or less was found below 70 feet depth at the flood or high water stage. This water corresponds to the Subartic water (Sverdrup et al, 1945). The temperature differences between the high and low water show large values at the subsurface of the central part, indicating that the cold water comes from the south through the Block Island Channel (Fig. 6). The temperature distributions of Section III indicate that the colder water coming from Newport Bight was found again at the subsurface levels in the northern part. It is noted that the temperature at Stations 10 and 11 were always higher than at other stations, suggesting the effect of Block Island. The temperature at the high water is higher than at the low water except at the mid-depth of the northern part.

Salinity distributions were not always stratified as were the temperature distributions. In Section I, salinity at the flood and high water stage shows gradients in the horizontal directions,

due to the horizontally different inflow

[illegible]

[illegible]

[illegible]

[illegible]

from Newport Bight. Particularly the high salinity water at the depths below 50 feet in the central part corresponds to the low temperature and is the result of the inflow of Newport Bight water. The salinity at the ebb and low water stage becomes lower and more homogeneous, because the water once in the sound is stirred and mixed well with the low salinity bay water. This feature is also recognized in Section II, where the extremely high salinity water (above 32.00°/oo) was found near the bottom and at mid-depths of the central part during the flood and high water stage. This water has low temperature and corresponds to the Subarctic water south of the sound. In Section III, the salinity gradients are less pronounced than in other sections and also they seem to be less pronounced at the flood and high water stage than at the ebb and low water stage. However, the stations in this section were occupied less frequently than those in other sections and thus there is no clear cut pictures about the effect of tidal stages.

The temperature and salinity profiles of the western circuit are shown in Fig. 7 and 8, respectively. Owing to difficulties pertinent to a small boat, the western section (Station 1 to 5) was occupied only during ebb and low stage. These two figures indicate that in the middle of the ebb stage the water at the subsurface layers has low temperature (less than 15°C) and high salinity (above 31.8°/oo) but at the low water stage the temperature already increases to more than 17°C and salinity also decreases to 31.5°/oo or less Therefore, in this section the characteristics of the water coming

from the open sea (mostly south of the Block Island Channel) are lost by mixing during a half tidal cycle (about 6 hours). The temperature and salinity profiles of the eastern section indicate that the water of the Subarctic origin coming through the Block Island Channel flows at the subsurface levels only in the central portion of this section which is deepest. Again this water has lower temperature and higher salinity at the flood or high water stage than at the ebb or low water stage.

The change of temperature and salinity (or any other passive quantities like oxygen and nutrient salts) can be described by the following transport equation

$$\frac{\partial S}{\partial t} + \vec{U}_h \cdot \nabla_h S + w \frac{\partial S}{\partial Z} = K_h \nabla_h^2 S + K_z \frac{\partial^2 S}{\partial Z^2} \qquad (3)$$

where S is the concentration of the passive quantity, $\vec{U}_h$ and w are horizontal and vertical velocity respectively, K the eddy diffusivity, ∇ the gradient vector and the suffices h and Z refer to horizontal and vertical respectively. Integration of Equation (3) with time yeilds the range of S in terms of currents, spatial variability of S and eddy diffusivity. In general, the range of S is proportional to velocity and gradient of S but

the eddy diffusivity which is increased by the current may decrease the range. In the present example the range of both temperature and salinity is larger at great depths in the part of the

section connecting through channels with the open sea (or Newport Bight). This is mostly due to the strong horizontal gradient there.

6. Horizontal distribution of temperature and salinity

In Fig. 9 horizontal distributions of the temperature measured with bathythermographs are plotted for two tidal stages: (A) is at the flood or the highwater and (B) is at the ebb or the low water. In Fig. 10 corresponding horizontal distributions of salinity measured with portable salinometers are plotted.

In the stage (A) the water with low temperature (Below 15° C) and high salinity (above 32°/oo) flows into the sound through the central protion (station 8) of the Block Island Channel except at the surface. This water is of the subpolar origin and its shoreward movement near the bottom was detected by the bottom floaters all along the Atlantic shelf north of Cape Hatteras (Bumpus, 1965). The central portion of the Block Island Channel is located at the head of the submarine canyon as indicated by the 120 feet depth contour. Thus the deep water of the subarctic origin flows along the canyon like a river flow due to the pressure gradient caused by the tides. This water below the 40 feet depth turns to the northwest in the sound as seen from the tongue of isotherms and isohalines. The water of similar origin enters the sound throught the channel between Block Island and the mainland but it has less salinity than the one from the south due to the mixing in Newport Bight (Stockton and Ayers, 1952), though its temperature is lower than in the proper sound water. This water

[illegible]

may cause the low salinity area below the 10 feet depth in the central part of the sound centered at St. 3 of the east circuit.

The temperature and salinity distributions in the ebb or low tide stage (B) show large differences from those in the stage (A) along the Block Island Channel. The water at the channel and northeast of it shows lower salinity and higher temperature below the upper layer than in the stage (A). This indicates that the water coming from the Newport Bight turns to the south and flows out through the Block Island Channel during the ebb stage, while the deep water of the subpolar origin comes through the channel during the flood stage moves first northwestward and then eastward in the sound. It flows out mostly along the northern coast of the sound and partly along the western edge of the channel during the ebb period. This pattern of the flow causes the belt of the water of low salinity and low temperature running from the channel to the northeast.

The exchange of the water between Block Island Sound and Long Island Sound is not effective in the area studied. Therefore, the influence of drainage from the Thames and the Connecticutt River seems to be almost negligible in the Block Island Sound, although the surface salinity less than $29.5^{o}/oo$ was observed in the Long Island Sound mainly east of the Connecticutt River (Stockton and Backus, 1952; Riley, 1956). Thus the hydrographic feature of the Block Island Sound is more similar to the straits connecting the two seas than an estuary, although its western part is modified by the effect of the Long Island Sound.

7. A mathematical model for mixing in the Block Island Sound.

Redield (1950) discussed the tides in the Long Island Sound System (Long Island Sound and Block Island Sound) as a combination of the westward moving primary wave and the eastward moving reflected wave, both of which decrease their amplitudes exponentially as they propagate Although this model is adequate for a general feature of the tides in the Long Island Sound System, large departures from the simple model are seen in Block Island Sound. The cotidal lines for the high and low water are plotted in Fig. 11 by use of the data listed in Tide Table of the U. S. Coast and Geodetic Survey in order to show the mode of propagation of the tide in the sound. The cotidal lines show much slower progress of the tide in the sound than determined by Redfield (1950), whose chart (Fig. 7) shows that the travel time of the tide from Block Island to the Race is less than 45 minutes. Particularly the effect of Montauk Point for refraction of the tide wave is stronger in the present chart than in Redfield's chart and thus Montauk Point becomes almost like an amphidromic point.

As discussed in the previous section, the water mass distribution in the sound is greatly affected by the outside water flowing through the south and east channels. It should be noted that the western portion of the sound is little influenced by the water of low salinity which is present to the west of the Connecticutt River. This feature can be explained schematically by the use of the Lagrangian method of describing the movement by tidal currents of different water masses.

When the horizontal vector for position of a water mass is designated by $\vec{r}$, the Lagrangian equation of motion becomes

$$d^2 \vec{r}/dt^2 = - \nabla p/\rho - k\, d\vec{r}/dt \tag{4}$$

where p is the pressure, ρ is the density, ∇ is the horizontal gradient, and k is the fuctional coefficient. The change of the property S of the water mass can be approximately described with the equation

$$d\, S/dt = -K\,(S - S_0) \tag{5}$$

where K is the mixing coefficient and S_0 is the value of S for the surrounding water. Both in equations (4) and (5) the differential with t indicates the differentiation along the path of the considered water mass.

The solution of equation (4) is actually quite complicated. However, if the current distributions are assumed to be known from the current charts prepared by C & G Survey, the paths of different water masses may be approximately determined. By use of this method, trajectories of

three typical water masses presenting in the sound are determined and plotted in Fig. 11. Then the change of temperature and salinity along these trajectories are computed from equation (5) by use of different values of S_0 corresponding to each trajectory. The values of K are assumed to be constant along the trajectories. Two examples from the results of such a calculation is plotted in Fig. 12, where the change of salinity with time for a complete tidal cycle is shown for two trajectories indicated in Fig. 11. The initial water mass in the eastern channel has salinity of 30^{o}/oo corresponding to the water mass of the Newpprt Bight, whereas the one in the southern channel has salinity of 32^{o}/oo of the water of subpolar origin. The two sets of K are used for each trajectory: $K = 3 \times 10^{-5}$ (sec^{-1}) and 1.5×10^{-4} (sec^{-1}). If it is assumed that a circular water column of diameter R is transported by tidal currents and mixes with surrounding water by horizontal diffusion, the four-thirds law of horizontal eddy diffusivity yields $K = 0.2\ R^{-2/3}$ (R and K in the c.g.s. unit) (Ichiye, 1957 a). Therefore the above values of K correspond to $R = 5$ km and 0.5 km respectively. Figure 12 indicates that the water from the south reaches its minimum salinity and the water coming from the Newport Bight reaches its maximum salinity at seven or ten hours after entering the sound. This figure also shows that both water masses lose their original salinity considerably after one tidal cycle.

8. Tidal flushing in Block Island Sound

Tidal flushing of a bay or estuary can be estimated either by the

tidal prism method or by the tranport equation method (Ichiye, 1967b) These two methods are applied to Block Island Sound. The tidal prism method is simple but not always satisfactory. The second method is more precise but sometimes the computation is quite complicated.

The original tidal prism method is to derive the exchange ratio r which is defined as $P/(P + V)$. In this relation P is the tidal prism and is defined as the difference of the high tide volume and the low tide volume which is designated as V. If the bay contains the total amount M of the pollutant at the low water stage, the amount of the pollutant left in the bay after the k-th tidal cycles equals $M(1 - r)^k$. The numerical values of Block Island Sound can be determined from C. & G.S. Tide Tables and the chart and are listed below:

Table 1

	P ($10^9 m^3$)	V ($10^9 m^3$)	r
Spring Tide	0.56	18.6	0.035
Mean Tide	0.58	18.6	0.029

The values of r are small compared with other byas on the south shore of Long Island (Ichiye, 1967b), because the mean depth of the sound (20.7m) is larger and the averaged tidal ranges (0.74m and 0.89m) are smaller than in these bays. However, smallness of r does not necessarily indicate low flushing rate, but rather is due to the deficiency in the classical tidal prism method.

In a modified tidal prism method, the effect of channels connecting a bay with the open sea is considered (Ichiye, 1967b). If it is assumed that dilution by the pure ocean water is completed during one flood period, the concentration s of the pure ocean water in the bay is given by

$$s(P + V) = \Sigma s_i U_i - s U_o \qquad (6)$$

where U_i and s_i are the volume transport coming through a channel from the outside during the flood period and its content of the pure ocean water respectively, and U_o is the volume transport flowing out from the bay. The law of conservation of the volume yields the relation

$$P = \Sigma U_i - U_o \qquad (7)$$

The values of U_o and U_i can be computed by use of the cross section of each channel from the chart and the current velocity estimated from the Tidal Current Charts of C & G.S. The results of such computation are shown in the following table

Table 2

South channel	East channel	Western channels	s_1	s_2	s
U_1	U_2	U_o	1	1	0.26
4.07	2.41	5.88	1	0.5	0.21

The coefficient s is almost similar to r and thus the amount of the pollutant in the bay after the k-th tidal cycles becomes $M(1 - s)^k$,

if it is assumed that there is no back flow of the pollutant by the transport U_o during the ebb period. Table 2 indicates that the flushing rate of the sound is much larger than the one estimated by the classical method.

The transport equation method is to solve the equation

$$d(V\bar{S})/dt = \Sigma\, S_i \quad U_i \tag{8}$$

where $\bar{S}$ is the averaged concentration of the water property in the bay, U_i is the volume transport per unit time through the i-th channel and S_i is the concentration of the property of the water transported through the channel. Thus, S_i becomes equal to $\bar{S}$ when the water flows out from the bay. The positive value of U_i corresponds to the inflow to the bay. This equation is a differential form of equation (5). The correponding volume conservation equation becomes

$$dV/dt \quad = \quad \Sigma\, U_i \tag{9}$$

The change of the averaged concentration $\bar{S}$ with time can be determined by integrating (8) with time. In order to solve equation (8) for the sound, U_i is determined from the Tidal Current Charts of C & G.S. and the property S is taken as the salinity. The starting point is taken at the low water and the initial value of $\bar{S}$ is determined from the present observation. The values of S_i also may change with time and actually should be determined from the data obtained outside the channels during a period of the inflow transport. However, there is no adequate data available. Therefore, they are computed

by interpolation of the low water and high water values measured by Ayers and others (1952). The results of the integration of equation (8) are shown in Fig. 13. This figure indicates that the salinity S averaged over the bay changes substantially between the low and high water stages, corresponding to a rather large flushing rate determined by the modified tidal prism theory. In this figure the values of S estimated from the observed salinity by the present survey are plotted. These values are not exactly the average over the whole bay and yet a general trend of their change withtime and the range of these values seem to agree with the computed curve.

9. Concluding Remarks.

The change of water masses in the Block Island Sound due to tidal currents is complicated due to several conditions. One such is that the water of the subpolar origin flows into the sound at the subsurface through the southern channel. Another is that the water coming from Newport Bight through the eastern channel is more deleted by the drainage than the water from the south. A different approach in studying these water masses is to follow the water mass either by bouys or ships during one tidal cycle.

ACKNOWLEDGEMENTS

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Key

T. - Type (D: Deep type, S: Shallow type)
W. - Weather
T. - type (Cloud)
A. - Amount (Cloud)
Buc. - Bucket

BATHYTHERMOGRAPH DATA

The R/V EASTWARD: Curise E-24-67, May 1967

St.	T.	Day	Time Hr. M.	Lat.	Lon.	Sonic Depth fms.	Air Temp °C Dry B.	Air Temp °C Wet B.	Air P.	W.	Cloud T.	Cloud A.	Ht ft.	P. Sec.	Buc. °C Temp
1	S	22	10 00	34°28.0'N	76°35.0'W	16.0	19.2	18.6	1015.0	2	7	8	3	5	20.0
2	S	22	11 30	34°24.5'N	76°31.5'W	6.0	19.7	19.4	1016.0	2	7	8	3	6	20.1
3	S	22	12 15	34°20.6'N	76°27.5'W	10.0	19.7	19.2	1016.0	2	7	8	4	6	20.1
4	S	22	13 00	34°16.5'N	76°22.0'W	15.0	19.4	19.8	1015.0	2	5	8	4	5	20.05
5	S	22	13 30	34°13.0'N	76°19.0'W	15.0	21.1	20.0	1014.5	2	5	8	4	5	20.15
6	S	22	14 10	34°10.5'N	76°15.5'W	23.3	20.6	20.3	1014.0	2	5	8	4	5	22.2
7	S	22	14 45	34°07.5'N	76°09.5'W	68.3	21.1		1013.5	2	5	8	4	5	25.6
8	D	22	15 30	34°04.3'N	76°05.0'W	191.3	23.6		1012.1	2	5	8	5	5	26.4
9	D	22	16 28	34°00.0'N	7[illegible]°00.0'W	275.0	25.0		1011.5	6			7	6	26.0
10	D	23	01 40	33°49.0'N	75°41.0'W	1613.06	25.0		1005.8	6			7	6	25.6
11	D	23	06 25	33°43.2'N	75°15.1'W	1771.1	22.5		1007.5	2	6	8	3	5	22.7
12	D	23	16 35	34°24.7'N	75°04.5'W	1749.8	21.1		1008.0	2	6	8	6	5	23.0
13	D	23	18 35	34°25.0'N	75°02.5'W	1667.74	21.9		1008.0	6	6	8	7	5	24.7
14	D	23	20 45	34°25.0'N	75°02.5'W	1618.5	21.4		1008.2	6			7	5	25.7
15	D	24	06 30	35°00.0'N	75°00.0'W	874.8			1008.8	2	5	8	8	5	25.4
16	D	24	12 00	35°17.0'N	74°37.5'W	1377.9	21.1		1008.9	2	5	8	7	5	24.5
17	D	24	14 00	35°31.5'N	74°26.5'W	1315.0	21.1		1008.8	2	5	8	8	6	26.05
18	D	24	16 00	35°45.0'N	74°20.0'W	1271.3	18.1		1008.2	2	5	8	13	6	26.0
19	D	25	05 45	36°21.0'N	73°55.8'W	14[illegible].0	15.6		1008.0	6	5	8	10	6	17.65
20	D	25	10 10	36°19.6'N	74°09.5'W	1[illegible]34.1	10.6		1012.5	2	5	8	12	6	11.3
21	D	25	11 40	36°18.0'N	74°21.0'W	106.62	16.1		1012.8	2	6	8	6	5	13.9
22	D	25	15 05	36°15.0'N	74°32.5'W	86.3	13.9		1013.0	1	7	2	5	6	15.35
23	D	25	16 15	36°16.2'N	74°45.2'W	24.4	10.6		1013.0	0	0	1	4	5	10.65
24	D	26	00 00	35°12.5'N	74°58.5'W	62.06	18.6		1013.3	0	0	1	2		26.15

Table 1

UCONN Hydrographic Stations (August, 1965)

Date 17; Time 1130 ; St. No.1 U; Air Temp. 26.1 °C; Wind Sp.Calm; Clouds: Fog Stratus 10; Waves: Height 1m;

Depth(ft)	Temp.(°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.88	31.36	5.75
10	17.80	30.56	5.70
20	18.08	31.48	
30	17.64	31.00	5.75
40	18.20	31.44	
50	18.04	31.52	
60	18.08	31.40	

Date 17; Time 1228 ; St. No.3 U; Air Temp. 27.0 °C; Wind: Sp. Calm; Clouds: Haze Stratus 8; Waves: Height 1m;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.08	30.08	6.14
10	18.24	30.80	6.23
20	19.60	31.92	
30	17.28	30.76	6.19
40	16.60	30.00	
50	16.96	31.52	
60	15.00	30.60	
80	14.96	31.40	
100	14.52	31.52	

Date 17; Time 1445 ; St. No.4 U; Wind: Sp. 2-3 kts., Dir. S; Clouds: Haze Stratus 8; Waves: Height 1m, Per. 7;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	17.72	30.24	6.12
10	17.72	30.60	6.06
20	17.64	30.88	
30	17.60	31.52	6.13
40	17.24	31.40	
50	17.20	31.56	
60	17.12	31.72	
80	15.52	31.84	

Date 17; Time 1445 ; St. No.5 U; Wind: Sp. 3 k, Dir. S; Clouds: Stratus 8, Haze 0; Waves: Ht. 1m, Per. 7;

Depth(ft)	Temp. (^{o}C)	Salinity ($^{o}/oo$)	O_2 (ml/L)
0	16.92	30.32	6.10
10	16.32	31.52	6.11
20	16.04	31.40	
30	15.60	31.56	6.09
40	14.52	32.00	
50	13.28	31.20	
60	13.84	31.52	

Date 17; Time 1530 ; St. No.6 U; Wind: Sp. 3 k, Dir. S; Clouds: Haze 0; Wave: Ht. 2m, Per.6;

Depth(ft)	Temp. (^{o}C)	Salinity ($^{o}/oo$)	O_2 (ml/L)
0	19.12	30.92	5.80
10	19.00	31.00	5.73
20	18.52	31.20	
30	18.36	31.04	5.89
40	18.60	31.16	
50	17.68	31.20	

Date 17; Time 1605 ; St. No. 7 U; Wind: Sp. 2k, Dir.SSE; Air Temp. 24.4^{o}C; Clouds: Cumulus 4; Waves: Ht. 2m, Per. 7;

Depth(ft)	Temp. (^{o}C)	Salinity ($^{o}/oo$)	O_2 (ml/L)
0	17.68	31.40	6.19
10	16.80	30.64	6.21
20	17.28	31.68	
30	16.80	31.28	6.07
40	16.20	31.60	
50	15.68	31.80	

Date 17; Time 1630 ; St. No.8 U; Wind: Sp. 3 k, Dir. SSE; Air Temp. 26.1^{o}C; Clouds: Cumulus Nebulous 6; Waves: Ht. 1.5m, Per. 7;

Depth(ft)	Temp. (^{o}C)	Salinity ($^{o}/oo$)	O_2 (ml/L)
0	21.76	31.64	5.81
10	20.84	31.80	5.91
20	17.28	31.72	
30	16.80	31.44	6.35
40	16.24	31.64	
50	14.00	31.72	
60	13.04	31.56	
80	10.28	31.64	

Date 17; Time 1700 ; St. No.9 U; Wind: Sp. 5 k, Dir. SE; Air Temp. 25.8°C; Clouds: Cumulus, Cirrus 4; Waves: Ht. 1m, Per. 5;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.20	31.24	6.14
10	18.40	31.68	6.27
20	13.28	32.28	
30	12.96	31.72	6.25
40	13.12	32.08	

Date 17; Time 1730 ; St. No.10 U; Wind: Sp. 2 k, Dir. SE; Air Temp. 26.0°C; Clouds: Cirrus 2; Waves: Ht. 0.5m, Per. 3;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.12	31.64	
10	18.12	31.92	6.16
20	17.80	31.40	
30	18.12	31.80	6.10
40	18.04	31.96	

Date 18; Time 0733 ; St. No.11 U; Wind: Sp. Calm; Air Temp. 23.1°C; Clouds Cirrus-Haze, Stratus 10; Waves: Ht. 2m, Per. 7;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.84	30.88	
10	18.56	31.28	
20	17.28	30.92	
30	16.76	30.88	
40	17.00	31.00	
50	16.72	31.32	
60	16.60	31.36	
80	16.20	31.00	
100	13.92	31.40	

Date 18; Time 0802 ; St. No.12 U; Wind: Sp. Calm; Air Temp. 25.5°C; Clouds Haze 10; Waves: Ht. 1.5m, Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.12	30.60	
10	17.56	30.40	
20	17.40	30.84	
30	17.96	30.92	
40	17.32	31.16	
50	16.60	31.24	
60	15.84	31.16	
80	14.92	31.32	
100	13.80	31.44	

Date 18; Time 0831 ; St. No.13 U; Wind: Sp. Calm; Air Temp. 25.6°C; Clouds: Stratus, Cirrus, Haze 10; Waves: Ht. 1m, Per. 5;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.76	30.44	6.41
10	19.44	30.76	6.51
20	17.44	30.64	
30	17.60	31.12	5.86
40	16.72	31.04	
50	16.08	31.16	
60	15.12	31.36	
80	14.08	31.36	
100	13.64	31.20	
120	12.00	31.76	

Date 18; Time 0856 ; St. No.14 U; Wind: Sp. Calm; Clouds: Stratus, Haze 10; Air Temp. 28.0°C; Waves: Ht. 0.5m, Per. 5;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	20.52	30.60	
10	19.72	30.60	
20	18.20	30.84	
30	17.00	30.72	
40	16.64	30.76	
50	16.52	30.72	
60	15.88	30.88	
80	13.80	31.28	
100	13.04	31.24	
120	11.60	31.36	

Date 18; Time 0930 ; St. No.1 U; Wind: Sp. B2 , Dir. SSE; Air Temp. 29.0°C; Clouds: Cirrus-Stratus, Haze 10; Waves: Ht. 1m, Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.32	31.00	5.25
5	18.36	31.08	6.00
20	18.20	30.92	
30	17.12	30.72	5.85
40	16.00	31.32	

Date 18; Time 0954 ; St. No.2 U; Air Temp. 28.2°C; Wind: Sp. B 2 , Dir. SSE;
Clouds: Cirrus 10; Waves: Ht. 1m; Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.24	30.84	
10	18.48	30.72	
20	17.80	30.72	
30	17.28	30.60	
40	16.60	30.80	
50	16.40	31.00	
60	16.20	31.08	
80	15.60	31.40	
100	13.68	31.40	
120	11.72	31.48	

Date 18; Time 1036 ; St. No. 3 U; Air Temp. 29.0°C; Wind: Sp. B 2-3 , Dir. S;
Clouds: Cirrus, Haze 8; Waves: Ht. 1.5m, Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	20.20	31.80	
10	19.04	30.56	
20	18.56	31.00	
30	18.40	30.88	
40	16.80	31.08	
50	16.56	31.16	
60	15.92	31.12	
80	13.60	31.72	
100	13.36	31.68	

Date 18; Time 1110 ; St. No.4 U; Air Temp. 27.0°C; Wind: Sp. B 2-3 , Dir. SSW;
Clouds: Cirrus, Haze 7; Waves: Ht. 2m, Per. 7;

Depth (ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.44	30.68	
10	18.68	30.24	
20	18.00	30.32	
30	17.80	30.48	
40	17.44	30.48	
50	17.32	30.60	
60	15.76	30.64	
80	14.60	30.88	

Date 18; Time 1145 ; St. No.5 U; Air Temp. 26.0°C; Wind: Sp. B 2-3 , Dir. SSW
Clouds: Stratus, Cirrus 7; Waves: Ht. 2m, Per. 7;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.20	30.64	
10	17.88	30.24	
20	17.60	30.40	
30	17.20	30.32	
40	16.88	30.52	
50	16.84	30.24	
60	16.40	30.48	

Date 18; Time 1230 ; St. No.6 U; Wind: Sp. B 2-3 , Dir. S; Clouds: Cumulus, Cirrus 3;
Waves: Ht. 2m, Per. 7;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.40	29.96	6.11
10	17.84	30.40	6.32
20	17.88	30.40	
30	17.84	30.40	6.03
40	17.80	30.20	
50	17.64	30.40	
60	17.72	30.44	

Date 18; Time 1255 ; St. No.7 U; Wind: Sp. B 2 , Dir. S; Clouds: Cumulus, Cirrus 4;
Waves: Ht. 1.5m, Per. 7;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.40	30.04	
10	17.60	30.80	
20	16.80	31.00	
30	16.40	30.64	
40	16.40	31.40	
50	16.20	30.80	

Date 18; Time 1323 ; St. No.8 U; Wind: Sp. B 2 , Dir. S; Clouds: Cumulus, Cirrus 4;
Waves: Ht. 1m, Per. 7;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.52	30.80	5.64
10	17.28	31.32	5.62
20	15.36	31.40	
30	14.16	32.24	5.65
40	11.48	33.04	
50	11.28	32.00	

Date 18; Time 1350 ; St. No.9 U; Wind: Sp. B 2-3 , Dir. S; Clouds: Cirrus, Cumulus 4;
Waves: Ht. 1m, Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.52	31.12	
10	17.44	31.24	
20	17.20	31.32	
30	17.00	31.40	
40	16.48	31.24	
50	16.20	31.28	
60	16.00	31.56	
80	16.00	31.56	

Date 18; Time 1415 ; St. No.10 U; Wind: Sp. B 2-3 , Dir. S; Clouds: Cirrus, Cumulus 5;
Waves: Ht. 1m, Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	22.92	32.04	5.73
10	22.48	31.64	5.84
20	18.80	31.40	
30	16.04	31.28	6.25
40	16.16	31.32	

Date 18; Time 1437 ; St. No.11 U; Wind: Sp. B 2 , Dir. S; Clouds: Cirrus, Cumulus 6;
Waves: Ht. 0.5m, Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.00	31.04	
10	18.00	31.40	
20	17.68	31.32	
30	17.52	31.28	
40	17.20	31.52	
60	17.24	31.40	
80	17.00	31.40	
100	15.04	31.28	

Date 18; Time 1502 ; St. No.12 U; Wind: Sp. B 2 , Dir. S; Clouds: Cumulus, Stratus 7;
Waves: Ht. 0.5m, Per. 7;

Depth(ft)	Temp. (^oC)	Salinity ($^o/oo$)	O_2 (ml/L)
0	19.32	31.00	
10	18.80	31.68	
20	17.60	30.84	
30	17.76	30.84	
40	17.40	30.72	
50	17.16	30.72	
60	17.20	31.16	
80	16.32	31.28	
100	15.12	31.12	
120	14.40	30.88	

Date 18, Time 1510 ; St. No. 13 U; Wind: Sp. B 2-3, Dir. S; Clouds: Cumulus, Stratus
Waves: Ht. 0.5m, Per. 7;

Depth(ft)	Temp. (^oC)	Salinity ($^o/oo$)	O_2 (ml/L)
0	19.68	31.32	6.39
10	19.52	31.28	6.39
20	18.48	31.28	
30	17.88	31.08	6.55
40	17.80	31.20	
50	17.72	31.28	
60	16.96	31.16	
80	15.84	31.20	
100	15.52	31.52	
120	11.92	31.60	

Date 18; Time 1539 ; St. No.14 U; Wind: Sp. B 2-3 ; Clouds: Cumulus, Cirrus 4; Waves:
Ht. 0.5m, Per. 7;

Depth(ft)	Temp. (^oC)	Salinity ($^o/oo$)	O_2 (ml/L)
0	20.80	30.80	
10	20.88	31.00	
20	18.60	31.12	
30	17.60	30.80	
40	17.52	30.84	
50	17.00	30.72	
60	14.80	31.12	
80	14.00	31.00	

Date 18; Time 1618 ; St. No.2 U; Wind: Sp. B 2' , Dir. SW; Clouds: Stratus, Cumulus 6; Waves: Ht. 0.5m, Per. 7;

	Depth(ft)	Temp. (^{o}C)	Salinity ($^{o}/oo$)	O_2 (ml/L)
	0	21.24	30.80	
10	10	21.52	31.00	
2	20	18.00	30.64	
	30	17.60	30.60	
	40	17.00	30.80	
	50	16.40	30.88	
	60	14.80	31.12	
	80	14.08	31.20	
	100	13.56	31.24	

Date 18; Time 1657 ; St. No.3 U; Air Temp. 23.3^{o}C; Wind: Sp. B 2-3' , Dir. SW; Clouds: Cirrus, Cumulus 10; Waves: Ht. 0.5m, Per. 7;

Depth(ft)	Temp. (^{o}C)	Salinity ($^{o}/oo$)	O_2 (ml/L)
0	19.40	30.48	
10	19.28	30.00	
20	17.60	30.48	
30	16.64	30.60	
40	16.72	30.52	
50	16.20	30.72	
60	15.68	30.76	
80	15.40	30.84	
100	13.64	31.04	

Date 18; Time 1728 ; St. No4 U; Air Temp. 22.8^{o}C; Wind: Sp. B 2' , Dir. SSW; Clouds: Cirrus, Cumulus 10; Waves: Ht. 1m, Per. 6;

Depth(ft)	Temp. (^{o}C)	Salinity ($^{o}/oo$)	O_2 (ml/L)
0	19.60	30.60	6.58
10	19.64	30.68	6.56
20	18.52	30.76	
30	17.80	30.68	6.35
40	17.72	30.80	
50	17.28	30.88	
60	16.28	31.08	
80	15.72	31.12	

Date 18; Time 1757 : St. No.5 U; Wind: Sp. B 2-3 , Dir. S; Clouds: Stratus, Cirrus 10;
Waves: Ht. 2m, Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.08	30.52	
10	18.00	29.92	
20	16.88	30.52	
30	16.56	30.52	
40	15.92	30.64	
50	15.68	30.80	
60	15.52	30.88	

Date 18; Time 1826 ; St. No.7 U; Air Temp. 22.2°C; Wind: Sp. B 2-3 , Dir. S; Clouds:
Fog, Cumulus-Stratus, Alto-Cumulus 10; Waves: Ht. 2.5m, Per. 7;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.16	30.56	
10	18.20	30.52	
20	18.24	30.52	
30	18.20	30.52	
40	18.16	30.52	
50	18.12	30.52	

Date 18; Time 1852 ; St. No.8 U; Air Temp. 22.1°C; Wind: Sp. B 4 ; Clouds: Fog,
Cumulus-Stratus, Alto-Cumulus 10; Waves: Ht. 2.5m, Per. 4-5;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.40	30.32	5.89
10	18.12	30.48	5.91
20	17.80	30.44	
30	17.48	30.48	6.26
40	17.00	30.64	
50	16.60	31.00	

Date 18; Time 1922; St. No.9 U; Air Temp. 23.1°C; Wind: Sp. B 2 , Dir. ESE; Clouds:
Fog 10, Cumulus-Stratus; WavesL Ht. 1.5m, Per. 6;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	20.84	31.04	
10	20.44	31.08	
20	19.80	31.04	
30	16.12	31.64	
40	14.80	31.16	
50	13.80	31.00	
60	12.80	31.20	

Date 18; Time 1945 ; St. No.10 U; Wind: Sp. B 3 , Dir. ESE; Clouds: 10; Waves: Ht. 2m, Per. 6;

Depth(ft)	Temp. (^{o}C)	Salinity (^{o}/oo)	O_2 (ml/L)
0	17.20	30.84	5.97
10	17.08	31.12	5.95
20	17.04	31.36	
30	17.00	31.24	6.14
40	17.12	30.84	

Date 19; Time 0809 ; St. No.11 U; Air Temp. 23.7^{o}C; Wind: Sp. B 2-3 , Dir. SW; Clouds: Stratus 10; Waves: Ht. 1.5m, Per. 7;

Depth(ft)	Temp. (^{o}C)	Salinity (^{o}/oo)	O_2 (ml/L)
0	18.80	30.60	
10	18.04	30.64	
20	17.96	30,80	
30	17.80	31.00	
40	17.76	31.00	
50	16.80	31.00	
60	16.56	31.12	
80	16.24	31.20	
100	15.00	31.20	

Date 19; Time 0832 ; St. No.10 U; Air Temp. 24.2^{o}C; Wind: Sp. B 3-4 , Dir. S; Clouds: Stratus, Cirrus 10; Waves: Ht. 2m, Per. 6;

Depth(ft)	Temp. (^{o}C)	Salinity (^{o}/oo)	O_2 (ml/L)
0	19.60	30.52	5.97
10	18.08	30.20	5.95
20	17.24	31.00	
30	17.00	30.96	6.14
40	16.96	30.92	

Date 19; Time 0856 ; St. No.9 U; Air Temp. 25.0^{o}C; Wind: Sp. 3 , Dir. SSW; Clouds: Stratus, Cumulus 10; Waves: Ht. 2m, Per. 6;

Depth(ft)	Temp. (^{o}C)	Salinity (^{o}/oo)	O_2 (ml/L)
0	19.40	30.72	
10	19.28	30.84	
20	17.60	30.88	
30	17.40	31.00	
40	17.12	31.04	
50	16.16	30.68	
60	14.72	31.00	

Date 19; Time 0915 ; St. No.8 U; Wind: Sp. B 3-4 , Dir. SW; Clouds: Stratus, Cumulus 1(
Waves: Ht. 2m, Per. 6;

Depth(ft)	Temp. (^oC)	Salinity ($^o/oo$)	O_2 (ml/L)
0	18.28	30.28	5.84
10	18.04	30.20	5.72
20	17.20	30.44	
30	16.32	30.60	5.79
40	16.28	30.56	
50	16.08	30.60	

Date 19; Time 0936 ; St. No.7 U; Wind: Sp. B 3 , Dir. SW; Clouds: Stratus 10; Waves:
Ht. 2m, Per. 6;

Depth(ft)	Temp. (^oC)	Salinity ($^o/oo$)	O_2 (ml/L)
0	18.56	30.20	
10	18.20	30.40	
20	17.68	30.48	
30	17.72	30.44	
40	17.60	30.48	
50	17.60	30.52	
60	17.60	30.48	

Date 19; Time 1005; St. No.6 U; Air Temp. 28.1^oC; Wind: Sp. B 3 , Dir. SW; Clouds:
Stratus 10; Waves: Ht. 2m, Per. 6;

Depth(ft)	Temp. (^oC)	Salinity ($^o/oo$)	O_2 (ml/L)
0	18.96	30.40	5.62
10	18.88	30.48	5.69
20	18.60	30.40	
30	18.64	30.40	5.62
40	18.80	30.44	

Date 19; Time 1031 ; St. No.5 U; Air Temp. 26.7^oC; Wind: Sp. B 2-3 , Dir. SW; Clouds:
Stratus 10; Waves: Ht. 1.5m, Per. 6;

Depth(ft)	Temp. (^oC)	Salinity ($^o/oo$)	O_2 (ml/L)
0	18.80	30.44	
10	18.48	30.40	
20	18.16	30.60	
30	16.84	30.64	
40	16.08	30.80	
50	15.88	30.64	
60	15.88	30.76	

Date 19; Time 1103 ; St. No.4 U; Air Temp. 27.3°C; Wind: Sp. B 2-3 , Dir. SW; Clouds: Stratus 10; Waves: Ht. 1.5m; Per. 5;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	18.88	30.60	6.12
10	18.72	30.56	5.97
20	18.12	30.76	
30	17.04	30.56	5.90
40	16.48	30.64	
50	16.00	30.84	
60	14.92	30.44	
80	14.76	30.92	
100	14.88	31.20	

Date 19; Time 1134 ; St. No.3 U; Air Temp. 29.0°C; Wind: Sp. 2 , Dir. SW; Clouds: Haze 10, Stratus; Waves: Ht. 1.5m, Per. 5;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.40	30.72	
10	19.28	30.80	
20	17.52	30.68	
30	17.00	30.64	
40	17.00	30.60	
50	16.68	30.80	
60	16.08	30.80	
80	14.72	30.96	
100	12.80	31.16	

Date 19; Time 1205 ; St. No.2 U; Air Temp. 27.7°C; Wind: Sp. 2 , Dir. SW; Clouds: Fog 10, Stratus; Waves: Ht. 1m, Per. 4;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	21.00	30.60	
10	20.72	30.60	
20	18.74	30.68	
30	18.20	30.88	
40	17.80	31.00	
50	17.36	30.96	
60	16.48	30.88	
80	15.08	31.08	
100	13.36	31.04	

Date 19; Time 1315 ; St. No.1 U; Air Temp. 2 . °C; Wind: Sp. 2-3k, Dir. S; Clouds: Nimbus 10, Stratus; Waves: Ht. 1m, Per. 4;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	20.40	31.12	5.82
10	19.08	31.04	5.96
20	17.64	31.04	5.80
40			5.80

Date 19; Time 2012 ; St. No.12 U; Wind: Sp.B2k, Dir. SW; Clouds: Rain 10; Waves: Ht. 1m, Per. 5;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	19.00	30.56	
10	18.72	30.64	
20	17.24	30.92	
30	17.28	30.88	
40	16.88	31.12	
50	16.48	31.12	
60	16.40	31.20	

Date 19; Time 2043 ; St. No.13 U; Wind: Sp.B2k, Dir. SW; Clouds: Rain 10; Waves: Ht. 0.5m, Per. 4;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	20.32	30.60	
10	20.16	30.52	
20	19.36	30.60	
30	18.60	30.92	
40	16.96	30.60	
50	16.80	30.76	
60	16.36	31.00	
120	12.20	31.52	

Date 19; Time 2112 ; St. No.14 U; Wind: Sp.B1-2k, Dir. SW; Clouds: 10; Waves: Ht. 0.5m, Per. 4;

Depth(ft)	Temp. (°C)	Salinity (°/oo)	O_2 (ml/L)
0	21.12	30.84	
10	20.36	30.88	
20	18.32	31.52	
30	17.88	31.52	
40	16.72	31.20	
50	15.40	31.28	
60	15.28	31.40	
80	14.84	31.40	
120	12.24	31.52	

Table 2

CONRAD, Jr. Hydrographic Stations (August, 1965)

Date 17th; Time 1358 EDT; Seq. No.1; St. No.1;

Depth (ft)	Salinity (°/oo)	Temp. (°C)
0	31.612	21.660
5	31.316	20.98
10	31.46	20.80
20	31.456	19.12
30	31.324	18.51
40	31.692	18.72
50	31.804	18.83
60	31.804	18.00
80	32.036	14.52

Date 17th; Time 1435 EDT; Seq. No.2
St. No.2.

Depth(ft)	Salinity(°/oo)	Temp(°C
0	31.312	20.98
5	31.316	19.45
10	31.240	19.23
15	31.164	19.23
20	31.456	17.77
30	31.040	18.84
40	31.540	19.16
50	31.752	18.92
60	31.940	17.74
80	31.880	15.90
100	32.096	15.64

Date 17th; Time 1510 EDT; Seq. No.3; St. No.3;

Depth (ft)	Salinity (°/oo)	Temp. (°C)
0	31.132	20.58
5	31.141	20.60
10	31.17	20.23
15	31.150	19.22
20	31.12	18.73
30	31.04	18.38
40	31.30	17.88
50	31.42	17.63
60	31.91	17.65
80	31.83	16.13
100	31.85	15.77
120	31.84	15.63

Date 17th; Time 1545 EDT; Seq. No.4
St. No.4

Depth(ft)	Salinity(°/oo)	Temp(°C
0	30.93	20.592
5	30.924	19.55
10	30.880	18.96
15	31.24	18.76
20	31.39	18.66
30	31.20	18.64
40	31.38	18.50
50	31.24	18.28
60	31.23	18.21
80	31.34	18.26
100	31.72	17.56

Date 17th; Time 1617 EDT; Seq. No.5; St. No.5;

Depth (ft)	Salinity (°/oo)	Temp. (°C)
0	30.70	21.06
5	31.14	20.48
10	31.21	19.86
15	31.13	19.56
20	31.35	19.44
30	31.09	19.34

Date 17th; Time 1647 EDT; Seq. No.6
St. No. 6

Depth(ft)	Salinity(°/oo)	Temp(°C)
0	31.31	20.28
5	31.20	20.09
10	31.21	19.20
15	31.37	18.68
20	31.41	18.35
30	31.52	18.27
40	31.60	18.19
50	31.42	17.72

Table 2

CONRAD, Jr. Hydrographic Stations (August, 1965)

Date 17th; Time 1719 EDT; Seq. No.7; St.7;

Depth (ft)	Salinity (°/oo)	Temp. (°C)
0	31.69	20.99
5	31.51	20.50
10	31.58	20.58
15	31.60	19.45
20	31.42	19.30
30	31.27	18.25
40	31.69	17.55
50	31.52	17.46
60	31.63	17.40
80	31.98	14.95
100	32.31	14.37
120	32.33	14.38

Date 17th; Time 1754 EDT; Seq. No.8; St.8

Depth(ft)	Salinity(°/oo)	Temp(°C)
0	31.40	21.28
5	31.35	21.06
10	31.33	20.48
15	31.33	18.73
20	31.50	18.27
30	31.55	17.28
40	31.60	16.95
60	31.62	16.54
80	32.10	13.82
100	32.396	12.98

Date 17th; Time 1819 EDT; Seq. No.9; St.9;

Depth (ft)	Salinity(°/oo)	Temp (°C)
0	31.30	22.03
10	31.35	21.10
20	31.24	19.39
30	31.43	17.71
40	31.60	17.18
60	32.10	15.74
80	32.42	14.12
100	32.44	13.70
120	32.40	13.57

Date 18th; Time 1054 EDT; Seq.No.10; St.1

Depth(ft)	Salinity(°/oo)	Temp(°C)
0	32.09	20.69
5	31.89	20.52
10	31.92	20.30
15	32.09	19.94
20	32.12	19.27
30	32.08	18.34
40	32.18	16.73
50	32.19	16.57
55	32.23	16.56

Date 18th; Time 1127 EDT; Seq.No.11; St.9

Depth (ft)	Salinity(°/oo)	Temp (°C)
0	31.48	22.00
5	31.29	19.14
10	31.48	18.47
15	31.48	18.20
20	31.28	17.95
30	31.31	17.60
40	31.54	17.51
50	31.64	17.17
60	31.49	17.02
80	32.08	16.09
100	32.35	14.85
120	32.20	13.33
140	32.37	13.23

Date 18th; Time 1157 EDT; Seq.No.12; St.8

Depth(ft)	Salinity(°/oo)	Temp(°C)
0	31.38	21.06
5	31.13	20.70
10	31.22	19.78
15	31.21	19.41
20	31.50	19.00
30	31.41	18.18
40	31.60	17.63
50	31.54	16.34
60	31.92	14.73
80	32.06	14.12
100	32.40	13.86

Table 2

CONRAD, Jr. Hydrographic Stations (August, 1965)

Date 18th; Time 1226 EDT; Seq. No. 13; St.7

Depth (ft)	Salinity (^{o}/oo)	Temp (^{o}C)
0	31.32	20.60
5	31.24	20.12
10	31.47	19.05
15	31.48	18.86
20	31.35	18.73
25	31.38	18.61
30	31.45	18.60
40	31.43	18.43
50	31.60	17.58
60	31.65	16.69
80	31.77	16.26
100	31.93	15.85
120	32.10	15.49
140	31.91	15.36

Date 18th; Time 1301 EDT; Seq. No. 14;

Depth (ft)	Salinity (^{o}/oo)	Temp(^{o}C)
0	31.24	19.78
5	31.24	19.58
10	31.13	19.38
15	31.09	19.33
20	31.29	19.23
30	31.33	18.69
40	31.88	18.48
50	31.50	18.72
60	31.48	18.28
80	31.52	17.54
100	31.61	17.52
120	31.66	17.52
130	31.66	17.47

Date 18th; Time 1352 EDT; Seq. No. 15; St.5

Depth (ft)	Salinity (^{o}/oo)	Temp (^{o}C)
0	31.16	19.82
5	31.26	19.57
10	31.15	19.36
15	31.42	19.26
20	31.22	19.25
25	31.35	19.13
30	31.25	18.73
40	31.53	18.65

Date 18th; Time 1421 EDT; Seq. No. 16;S

Depth (ft)	Salinity (^{o}/oo)	Temp(^{o}C)
0	30.90	20.80
5	30.92	20.21
10	30.87	20.09
15	30.98	20.06
20	31.09	19.90
30	31.03	19.05
40	31.13	18.67
50	31.09	18.71
60	31.18	18.56
80	31.20	17.90
100	31.52	17.72

Date 18th; Time 1446 EDT; Seq. No. 17; St. 3

Depth (ft)	Salinity (^{o}/oo)	Temp (^{o}C)
0	30.97	19.20
5	31.07	19.20
10	31.14	19.18
15	31.18	19.22
20	31.25	19.09
30	30.97	19.02
40	31.22	18.58
50	31.32	18.56
60	31.30	18.48
80	31.33	18.14
100	31.51	18.12
120	31.85	15.72
140	31.87	15.40

Date 18th; Time 1517 EDT; Seq. No. 18;S

Depth (ft)	Salinity (^{o}/oo)	Temp(^{o}C)
0	31.11	21.29
5	31.36	21.28
10	31.41	21.15
15	30.78	20.12
20	31.26	19.35
30	31.10	19.05
40	30.84	18.36
60	31.45	17.46
80	30.68	16.02
100	31.81	15.12
120	31.86	14.88

Table 2

CONRAD, Jr. Hydrographic Stations (August, 1965)

Date 18th; Time 1542 EDT; Seq. No. 19; St.1			Date 18th; Time 1622 EDT; Seq. No. 20; St.		
Depth (ft)	Salinity (°/oo)	Temp (°C)	Depth (ft)	Salinity (°/oo)	Temp(°C)
0	31.30	21.63	0	31.32	22.22
5	31.42	21.51	5	31.56	22.12
10	31.82	19.39	10	31.56	21.51
15	31.74	18.91	15	31.30	20.41
20	31.34	18.54	20	31.16	18.72
30	31.40	17.96	30	31.21	17.60
40	31.40	17.58	40	31.56	17.52
50	31.56	17.44	50	31.36	16.71
60	31.77	16.79	60	31.81	16.29
80	32.11	14.67	80	32.03	16.37
100	32.25	14.33	100	32.22	15.39
120	32.09	14.12	120	32.28	13.78

Date 19th; Time 1027 EDT; Seq. No. 21; St. 11			Date 19th; Time 1059 EDT; Seq. No. 22; St.		
Depth (ft)	Salinity (°/oo)	Temp (°C)	Depth (ft)	Salinity (°/oo)	Temp(°C)
0	31.38	20.83	0	31.64	21.10
5	31.63	20.55	5	31.53	20.93
10	32.00	19.69	10	31.44	19.96
15	31.94	18.84	15	31.82	19.58
20	32.21	18.08	20	31.55	19.58
30	32.09	17.54	25	31.77	19.68
40	31.95	16.91	30	31.77	19.41
50	31.96	16.44	40	31.48	19.38
60	31.91	16.26	50	31.90	18.00
80	32.38	15.58			
100	32.17	14.27			
120	32.38	13.96			

Date 19th; Time 1124 EDT; Seq. No. 23;St. 9			Date 19th; Time 1152 EDT; Seq. No. 24; St.		
Depth (ft)	Salinity (°/oo)	Temp (°C)	Depth (ft)	Salinity (°/oo)	Temp(°C)
0	31.46	20.89	0	31.36	20.74
5	31.41	20.76	5	31.49	20.14
10	31.44	20.28	10	31.40	19.97
15	31.44	20.09	15	31.54	19.78
20	31.33	20.04	20	31.41	19.52
30	31.50	18.80	30	31.54	19.47
40	31.37	17.64	40	31.63	18.73
50	31.45	17.11	50	31.55	18.32
60	31.65	16.28	60	31.56	16.77
80	32.15	15.18	80	31.94	15.71
100	32.20	14.36	100	32.15	15.38
120	32.20	13.85	120	32.18	14.90
			140	32.13	14.80

CORRIGENDA

Page 2	Line 6 from the bottom. "byoys" should read "buoys"
Page 3	Line 2 "Beanfort" should read "Beaufort" Line 6 from the bottom "Fig. 1 (A)" should read "Fig. 2 (A)"
Page 9	Line 5 from the bottom "yeilds" should read "yields"
Page 14	Line 6 "is plotted" should read "are plotted"
Page 15	Table 1 The P values of spring tide and mean tide are 0.68 and 0.56 respectively
Page 15	Line 6 from the bottom "byas" should read "bays"

Explanation of Figures

Fig. 1 Locations of hydrographic sections

Fig. 2 Comparisons of temperature and salinity values determined with portable salinometers and other instruments.

(A) Comparison of salinity values determined with a portable salinometer and a laboratory salinometer

(B), (C) Comparison of temperature values determined with portable salinometers and bathythermographs

Fig. 3 T - S diagrams from the data in the eastern circuit. (Circles Sts. 1-5; Triangles Sts. 6-9; Rectangles Sts. 10-14; the open and closed symbols represent data above and below 60 feet, respectively)

Fig. 4 Vertical sections of temperature in the eastern circuit (Locations of stations designated with numbers preceded by ST are shown in Figure 1)

Fig. 5 Vertical sections of salinity in the eastern circuit. (The numbers preceded by # indicate sequential order of the stations occupied.

Fig. 6 Ranges of temperature (A) and salinity (B) changes in the eastern circuit.

Fig. 7 Vertical sections of temperature in the western circuit.

Fig. 8 Vertical sections of salinity in the western circuit

Fig. 9 Horizontal distributions of temperature ($^{\circ}$C)

(A) Flood and high water stage

(B) Ebb and low water stage

(The depths in feet are indicated at the bottom right corner)

Fig. 10 Horizontal distributions of salinity ($^{\circ}$/oo)

(A) Flood and high water stage

(B) Ebb and low water stage

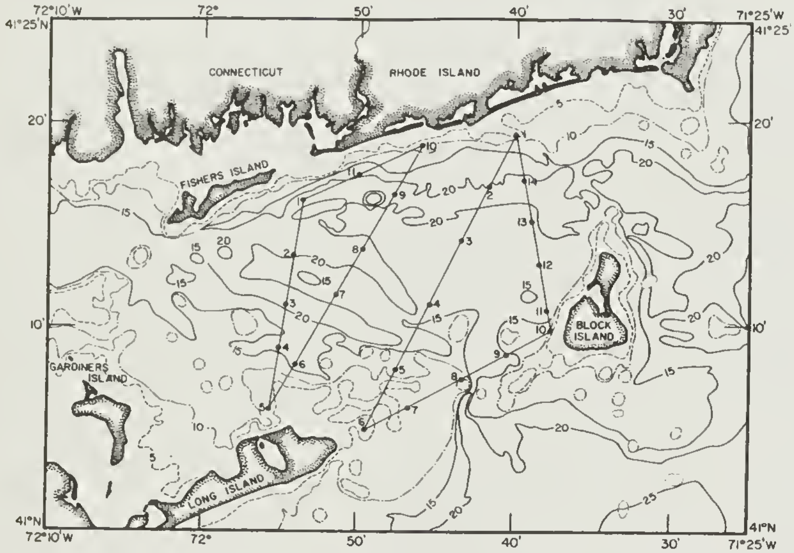
(The depths in feet are indicated at the bottom right corner)

Fig. 11 Trajectories of water masses during one tidal cycle starting from the beginning of the flood at the Race. (Each arrowhead indicates the position of the water mass after elapse of one hour.)

Fig. 12 Calculated change of salinity of the water mass moving along two trajectories during one tidal cycle. (The locations of the trajectories A and B are indicated in Fig. 11.)

Fig. 13 The theoretical and observed salinity averaged over the Block Island Sound. (The closed circles indicate the average from the observed data.)

FIG. 1



STATION LOCATIONS IN BLOCK ISLAND SOUND. CONTOURED IN FATHOMS.

FIG. 2 (B)

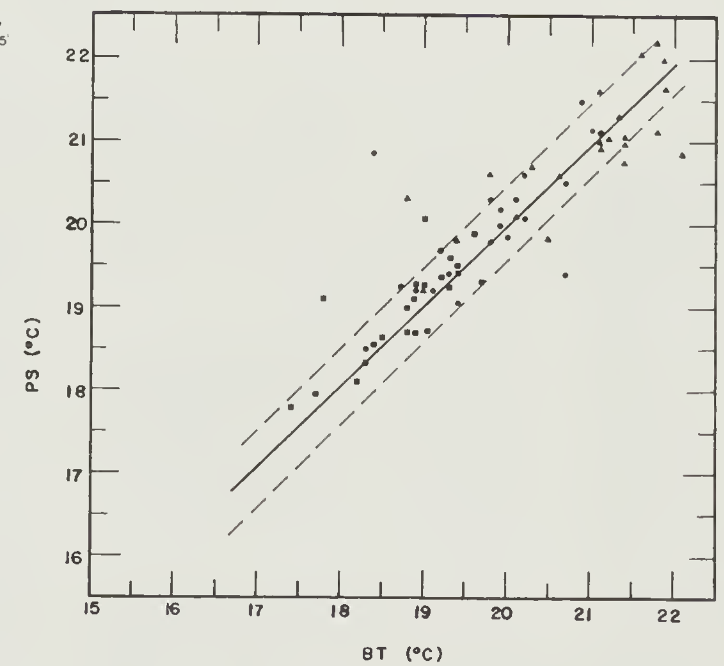


FIG.2(A)

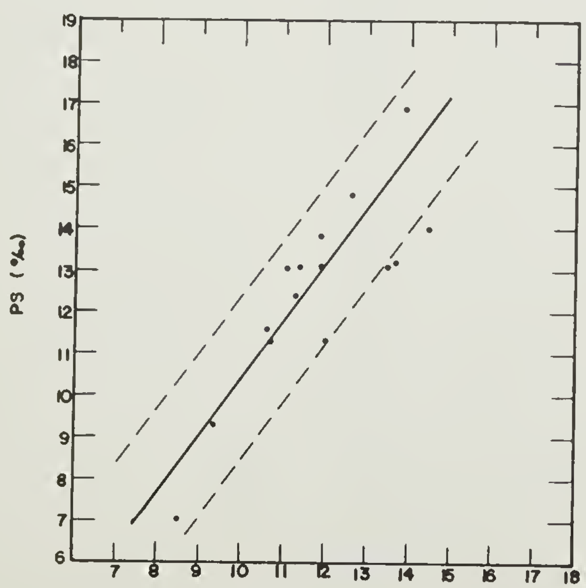


FIG. 2 (C)

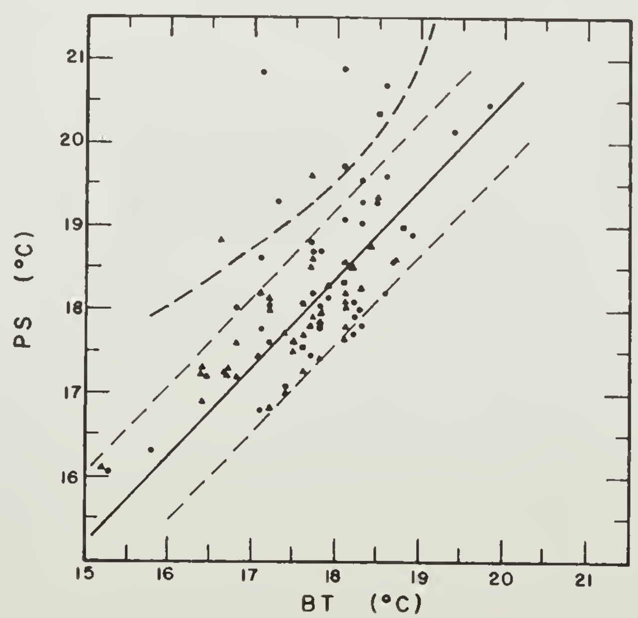


FIG 3

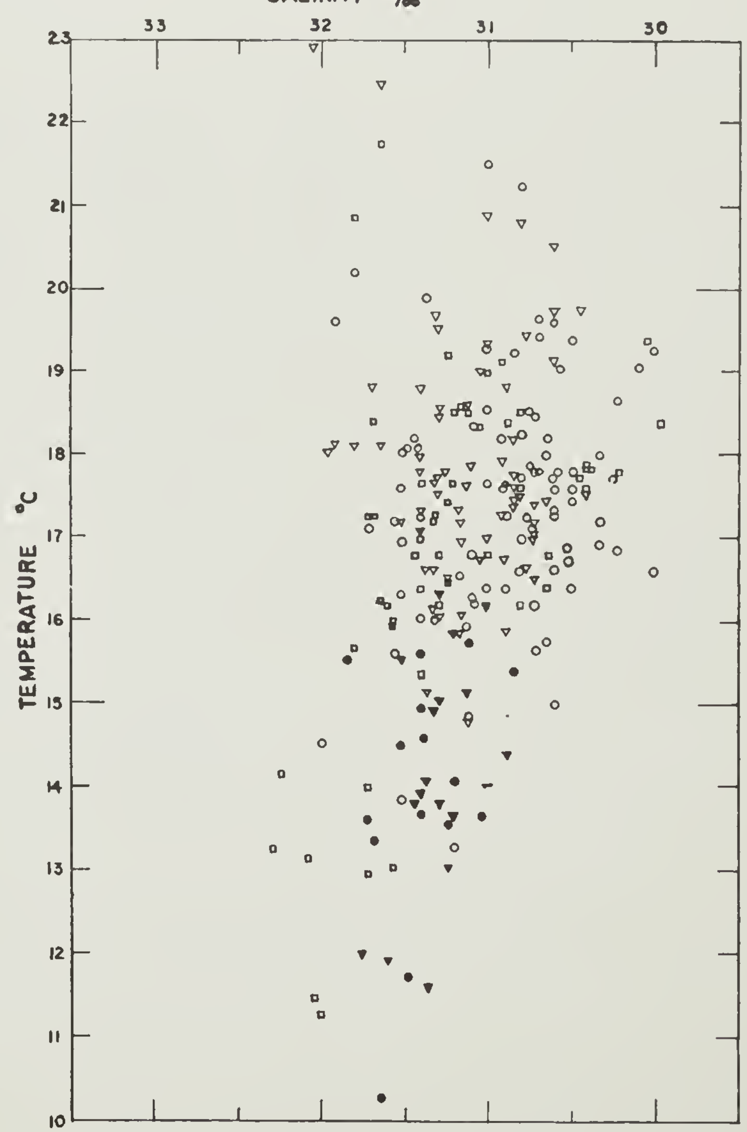


FIG. 4

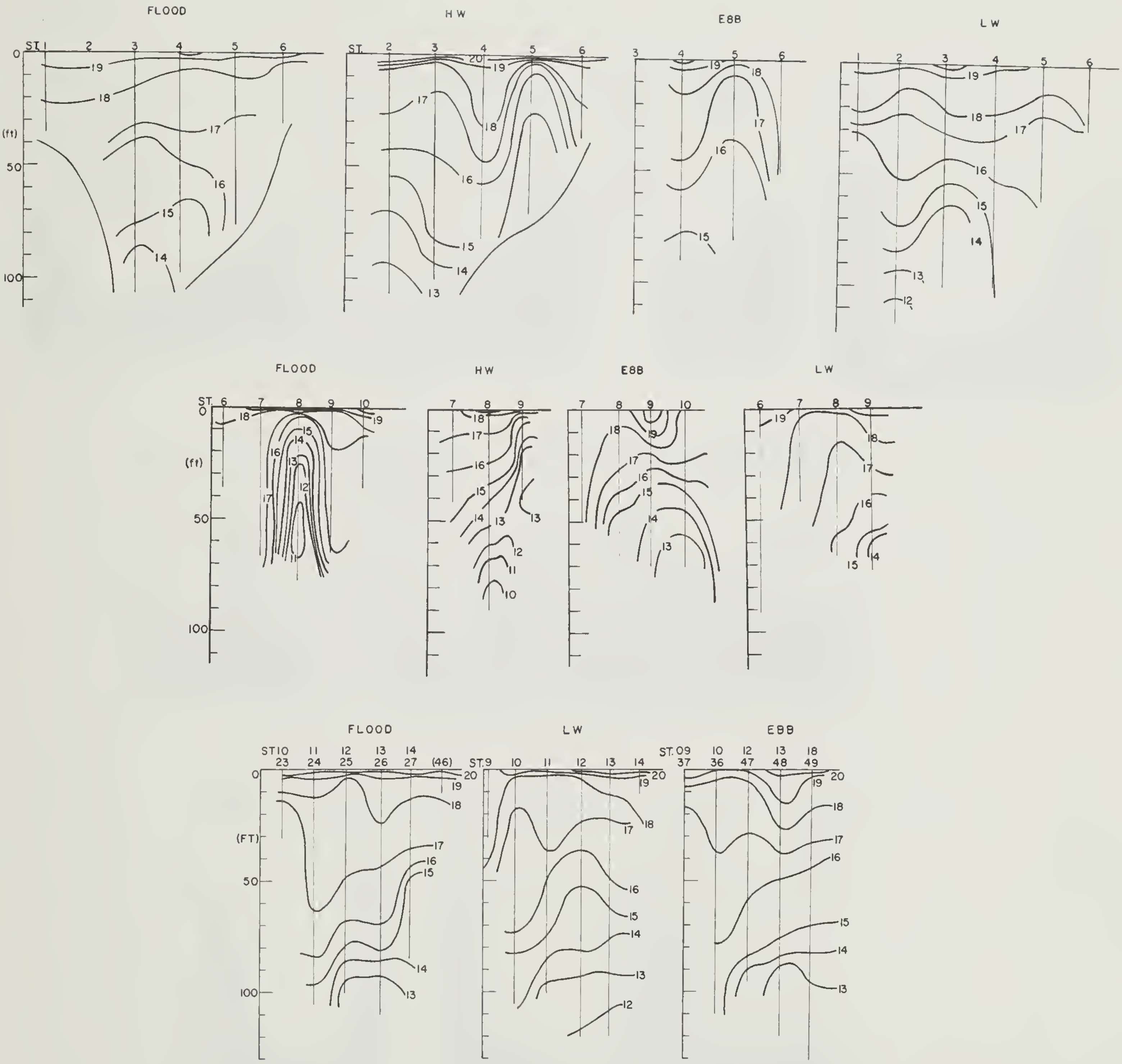

FLOOD
HW
EBB
LW
ST.
(ft)
0
50
100
FLOOD
HW
EBB
LW
ST.
(ft)
0
50
100
FLOOD
LW
EBB
ST10 11 12 13 14
23 24 25 26 27 (46)
ST.9 10 11 12 13 14
ST.09 10 12 13 18
37 36 47 48 49
(FT)
0
50
100

FIG. 5

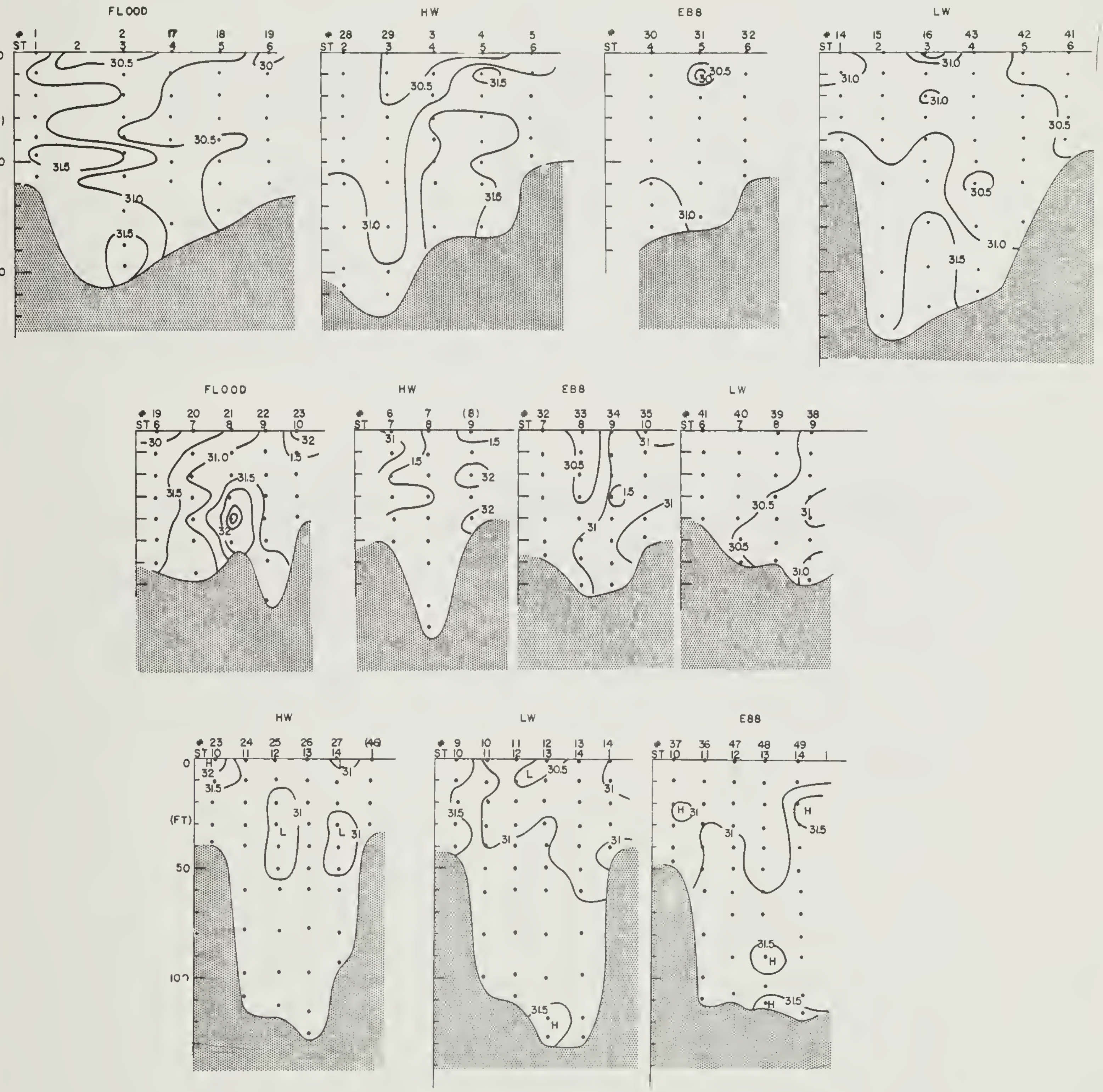


FIG. 6 (A)

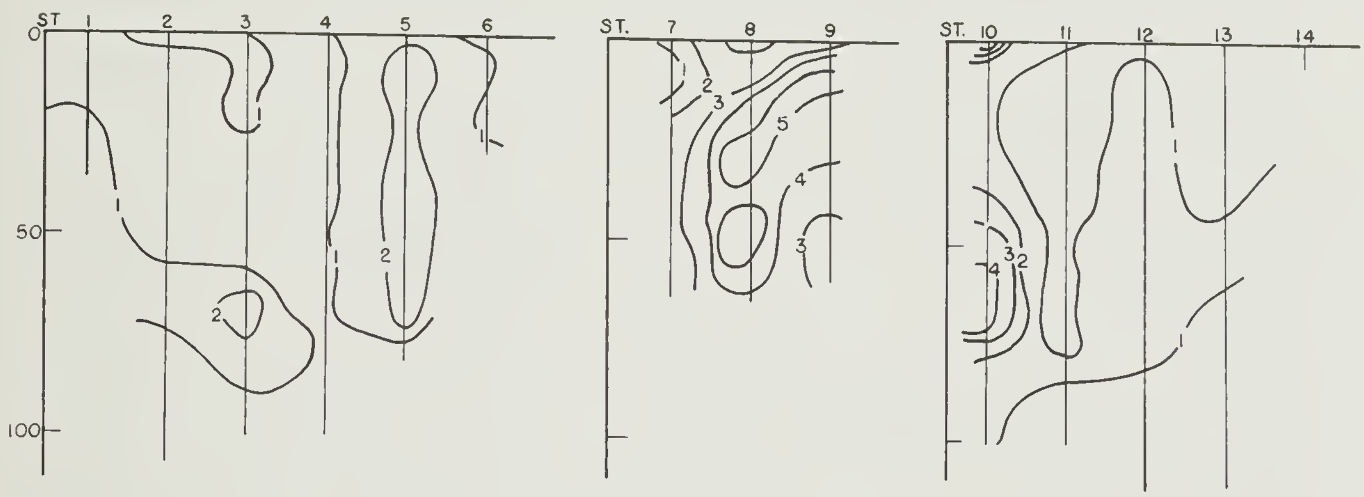

ST 1 2 3 4 5 6
ST. 7 8 9
ST. 10 11 12 13 14
0
50
100
2
2
1
2
3
5
4
3
4
3
2
1

FIG. 6 (B)

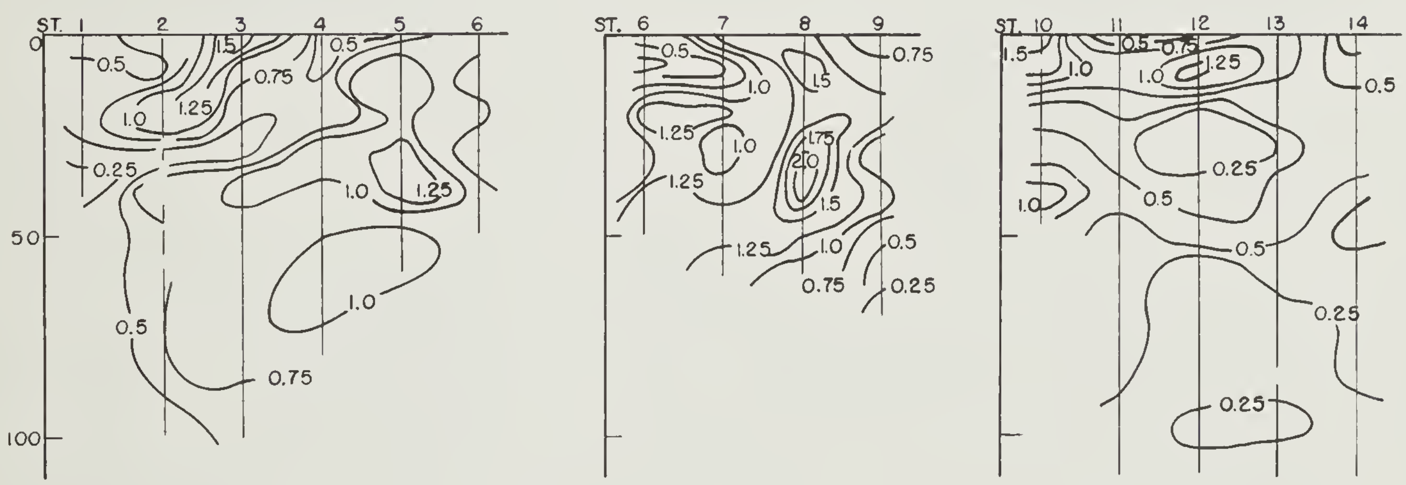

ST. 1 2 3 4 5 6
ST. 6 7 8 9
ST. 10 11 12 13 14
0
50
100
0.5
1.5
0.5
0.75
1.25
1.0
0.25
1.0
1.25
1.0
0.5
0.75
0.5
0.75
1.0
1.5
1.25
1.0
1.75
2.0
1.25
1.5
1.25
1.0
0.5
0.75
0.25
1.5
1.0
0.5
0.75
1.0
1.25
0.5
0.25
1.0
0.5
0.5
0.25
0.25

FIG. 7

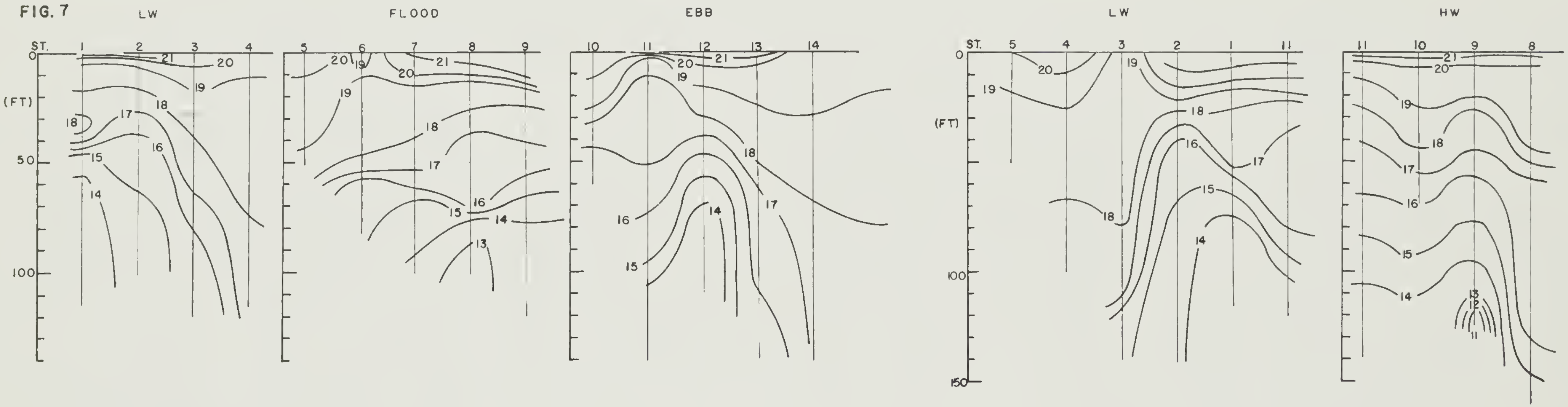

LW
FLOOD
EBB
LW
HW
ST.
(FT)
0
50
100
150

FIG. 8

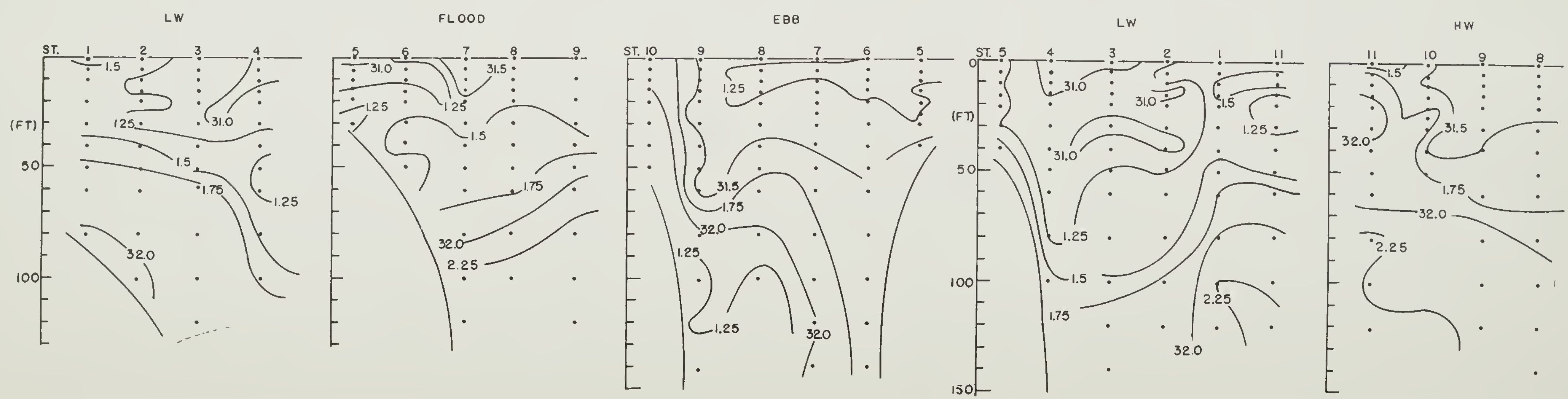

LW
FLOOD
EBB
LW
HW
ST.
(FT)
0
50
100
150

FIG 9 (A)

FIG 9 (B)

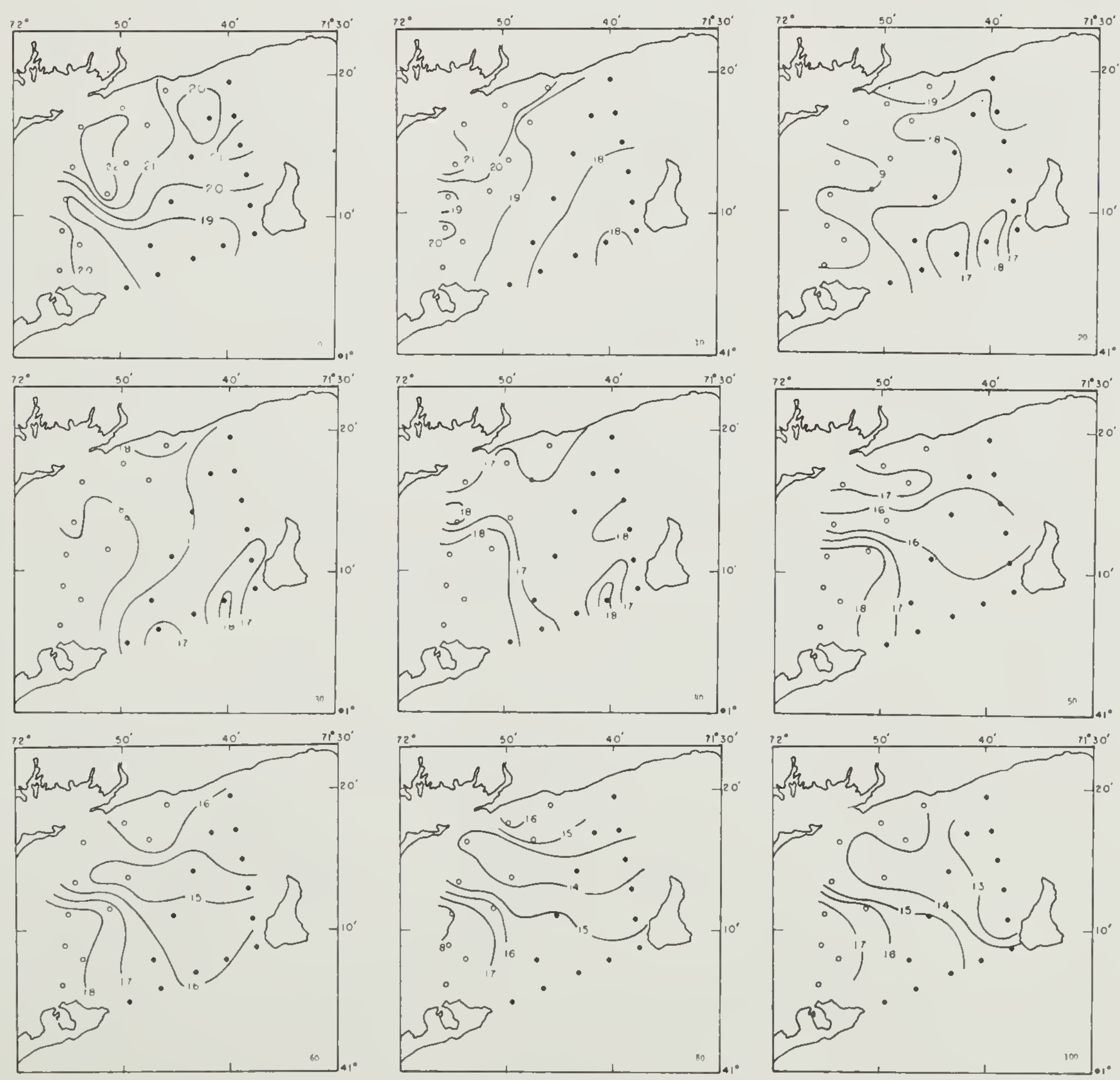


FIG 10(A)

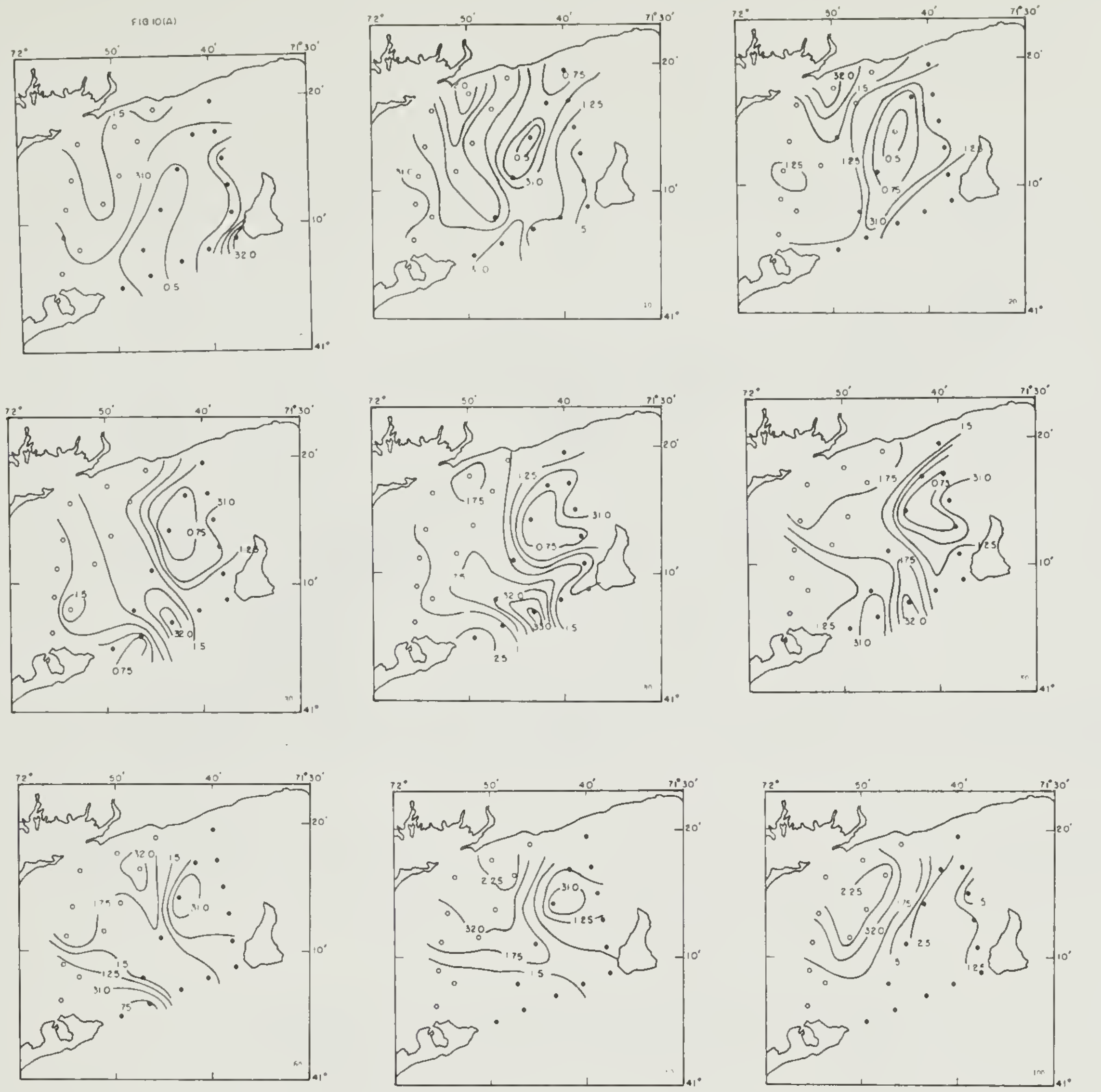


FIG 10(B)

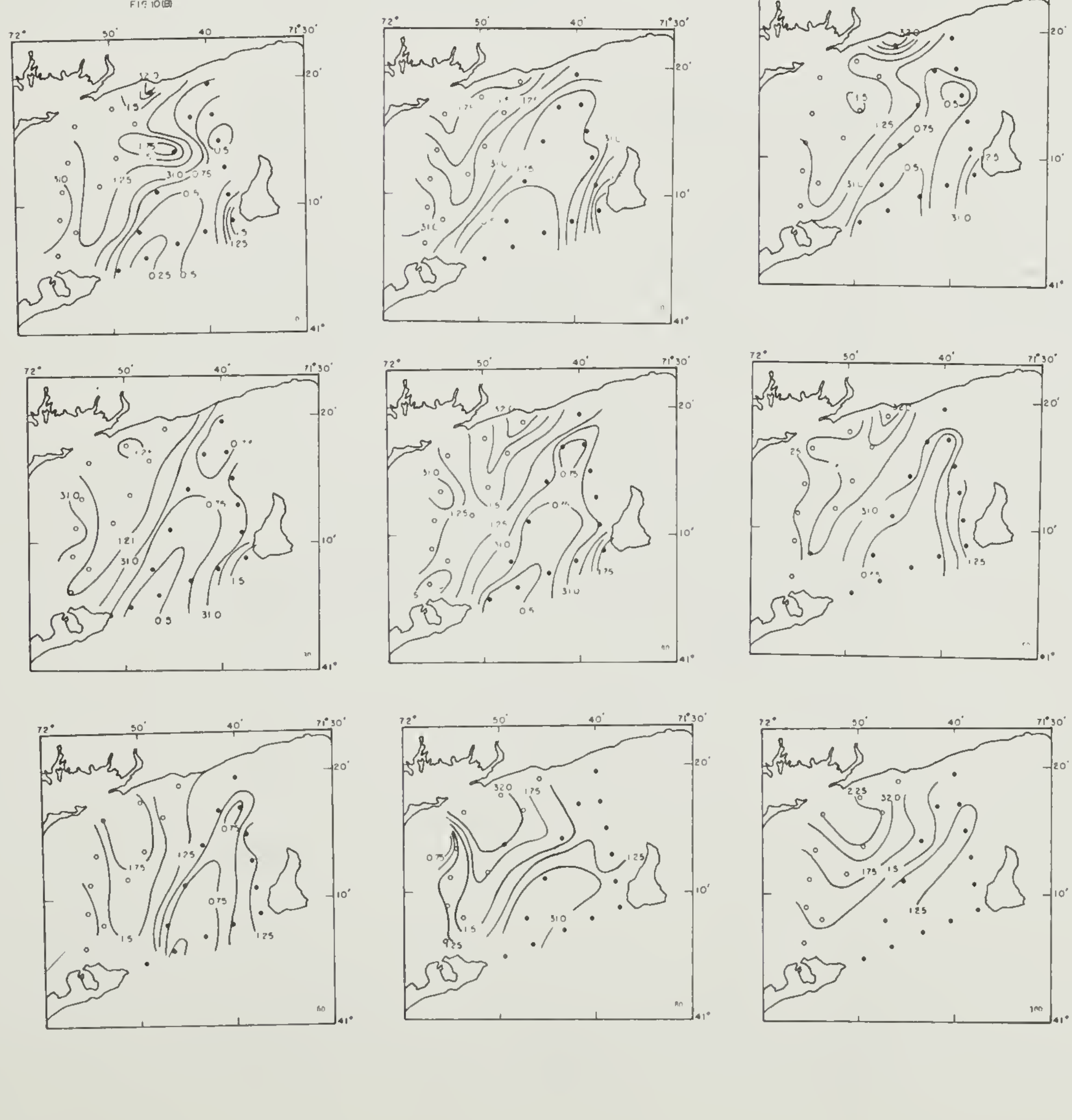


FIGURE 11

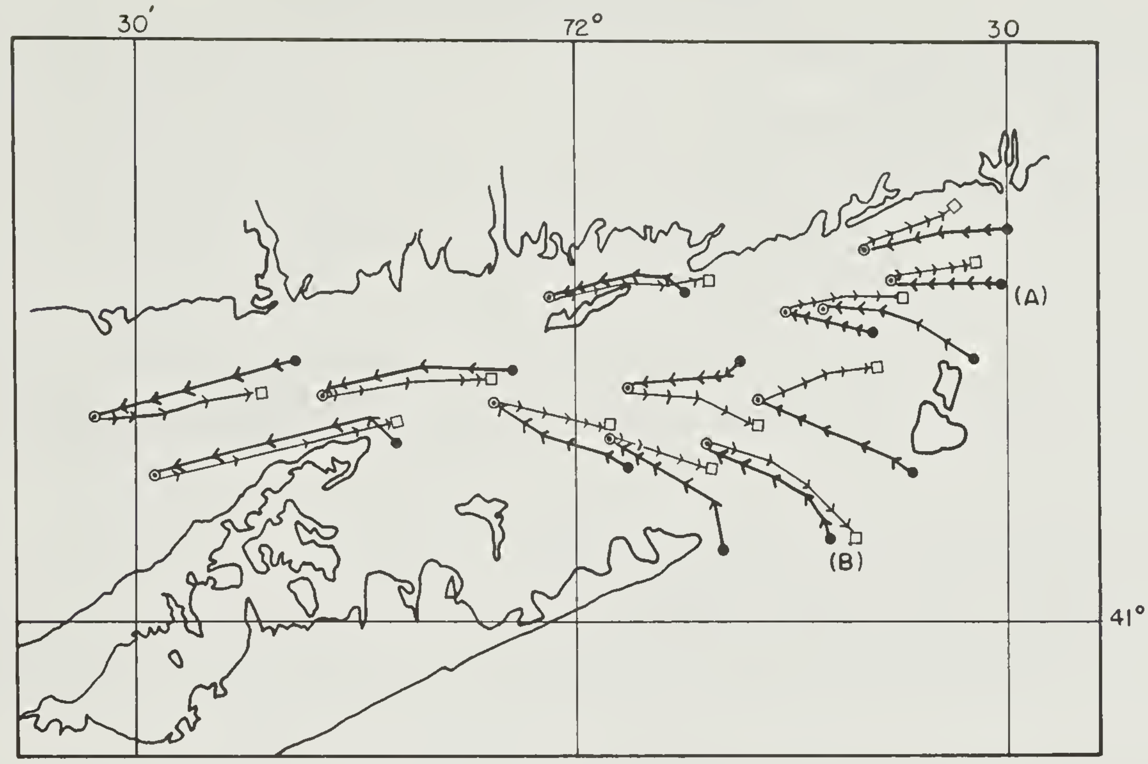


FIGURE 12

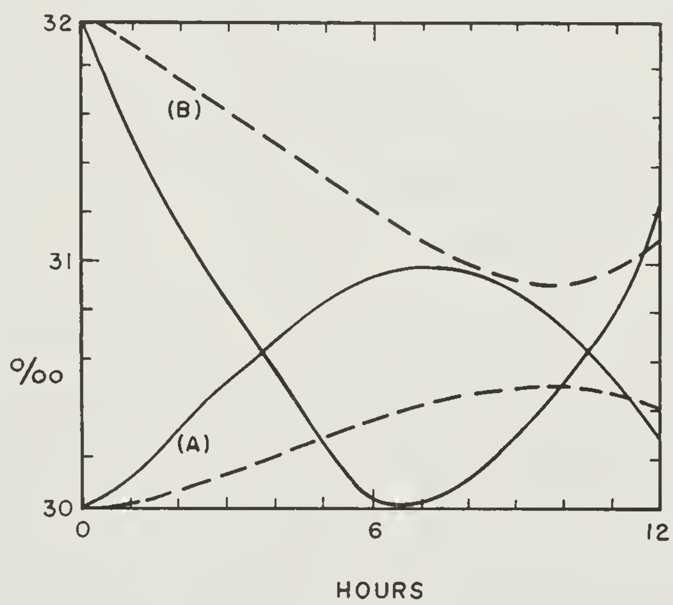
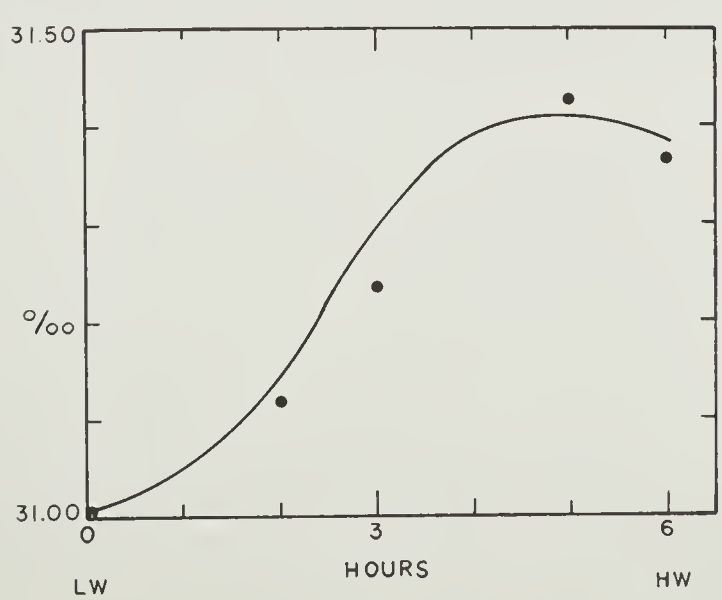


FIGURE 13



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13. ABSTRACT

A hydrographic survey of Block Island was made on August 17th to 19th on board the R/V UCONN and the CONRAD,JR. The two ships made several runs of two triangular circuits of stations, measuring temperature and salinity at all stations. The change of temperature and salinity due to tides reaches maximum at the deep layer in the center of the southern channel. The water of low temperature and low salinity flows into the sound from Newport Bight through the eastern channel during the flood and flows out through the southern channel during the ebb. The water of lower temperature and high salinity enters the sound through the southern channel during the flood and flows out along the northern coast of the eastern channel during the ebb. A simple mathematical model of Lagrangian method on mixing of water masses in the sound is proposed.

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	ROLE	WT	ROLE	WT	ROLE	WT
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